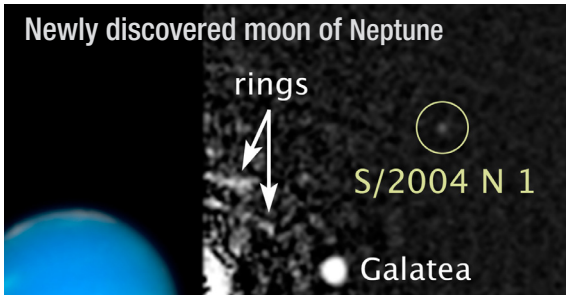
NASA's James Webb Space Telescope:
Observing Rings and Small Satellites with JWST

M.S. Tiscareno[1,2], M.R. Showalter[1], R.G. French[3], J.A. Burns[2], J.N. Cuzzi[4], I. de Pater[5], D.P. Hamilton[6], M.M. Hedman[7], P.D. Nicholson[2], D. Tamayo[8], A.J. Verbiscer[9]

Planetary rings are of prime importance as accessible natural laboratories for disk processes, as clues to the origins and evolution of planetary systems, and as shapers as well as detectors of their planetary environments. The retinue of small moons accompanying all known ring systems are intimately onnected as both sources and products, as well as shepherds and perturbers, of the rings. The James Webb Space Telescope (JWST) offers four major ways to investigate ring-moon systems with unprecedented sensitivity: **Discovering new rings and moons, Probing ring structure with occultations, Probing ring composition with spectroscopy, and Time-domain science.**

Discovering New Rings and Moons

- Small moons and faint rings trace a system's past and present workings
- At Uranus, the past was eventful, per discoveries by Hubble:
  - Moons lie in closely-packed orbits
  - Dusty rings with no apparent source
- JWST will improve upon Hubble with:
  - Comparable spatial resolution
  - Infrared coverage of fundamental absorption features and thermal emission
  - Greater sensitivity for deep searches



Cropped from a Hubble public release image.

NIRCam will provide very sensitive imaging that could yield new discoveries around Neptune (*Left*) and Uranus (*Right*), and improve our understanding of those systems.

Figure 1a of Showalter and Lissauer (2006, Science)

Figure 1b of Showalter and Lissauer (2006, Science)

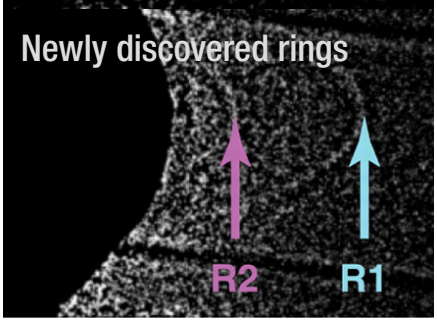
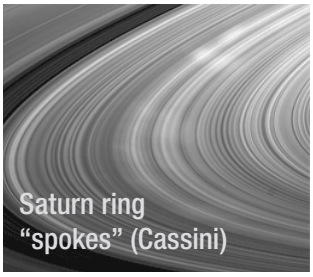


Figure 1c of Showalter and Lissauer (2006, Science)

Time-Domain Science

- JWST is well suited to observe objects that are
  - Faint
  - Recently discovered
  - Known to be changing
- Capturing systems in motion yields insights into
  - How and why they operate
  - System origins
  - Interactions w/ environment



Cassini public release image

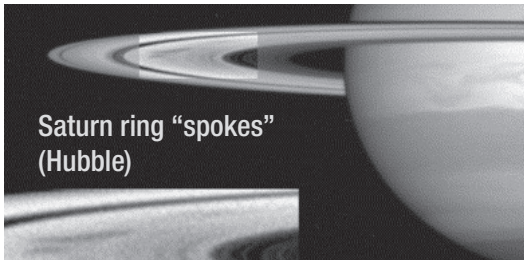
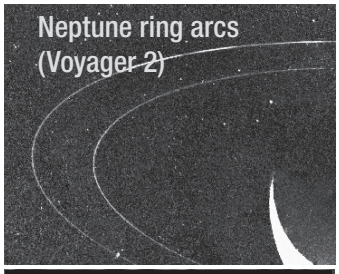


Figure 1 of McGhee et al. (2005, Icarus)



Voyager public release image

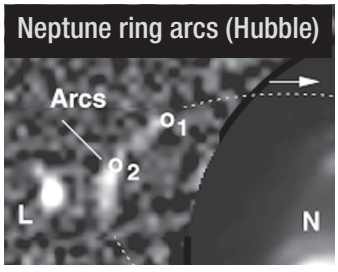
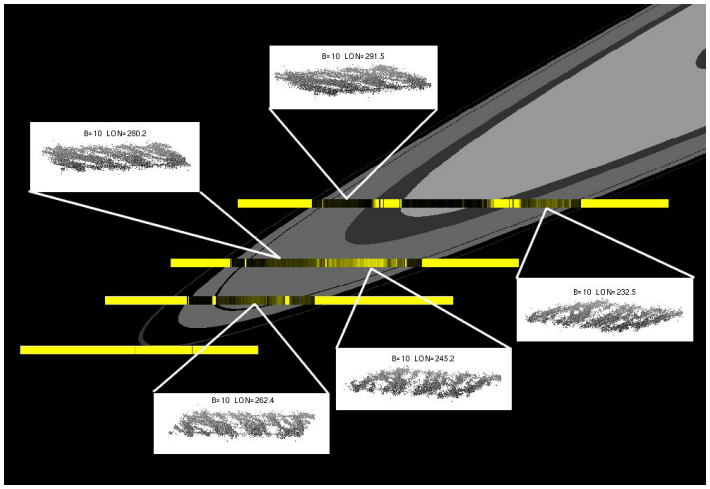


Figure 1 of Dumas et al. (1999, Nature)

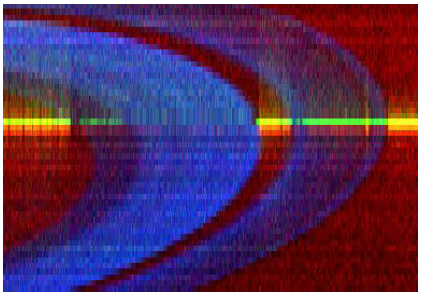
[1]SETI Inst, [2]Cornell U, [3]Wellesley Coll, [4]NASA Ames, [5]U California, [6]U Maryland, [7]U Idaho, [8]CITA, [9]U Virginia, [10]NASA Goddard, [11]STScI

Occultations

- JWST can observe the flickering of a star as it passes behind rings, revealing fine details of ring structure
- For Uranus and Neptune, JWST will greatly exceed the sensitivity of Voyager occultations
- Multiple occultations can build up a “CAT scan” of ring microstructure



Modified from Figure 1 of Hedman et al. (2007, AJ)

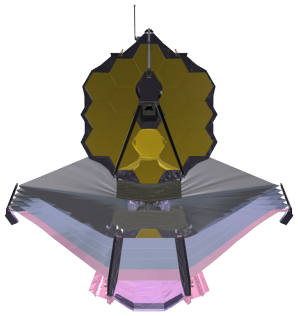


Cassini public release image

Left: Cassini observations of ring occultations revealed significant variations in ring properties as a function of azimuth, particularly in the B ring. *Above*: Cassini observation illustrating fluctuations in starlight as it passes through a ring. JWST can observe such events spectroscopically using the NIRSpec IFU.

Unprecedented Spectroscopy

- Compositions of rings and small moons in Uranus and Neptune systems
  - Very little is known from Voyager
  - Must be very different from Saturn
  - May hold clues to system origins
- IR spectroscopy of faint targets is JWST’s strong suit!



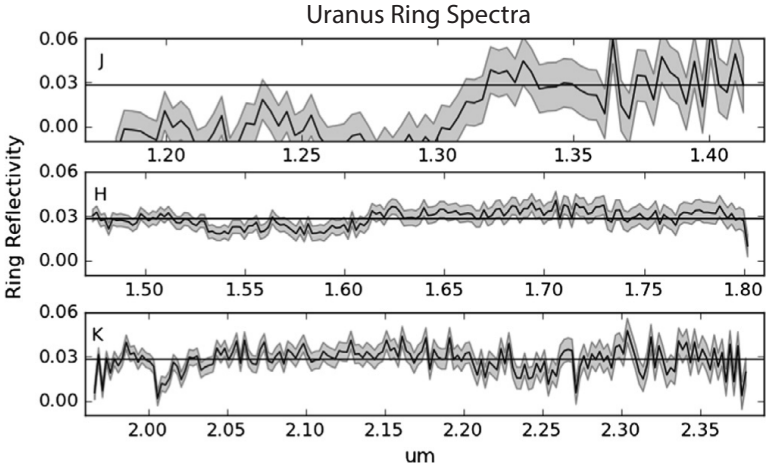
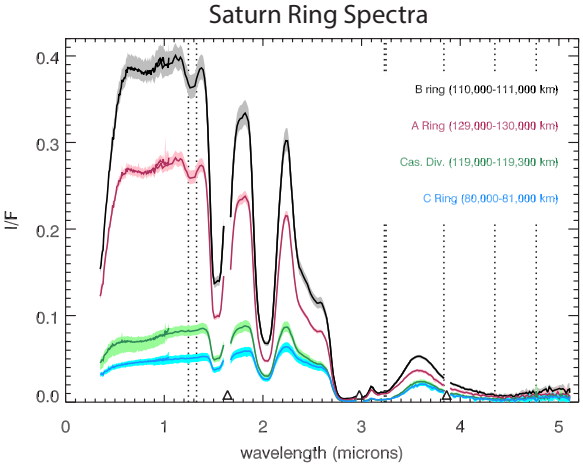


Figure 2 of de Kleer et al. (2013, Icarus 223, 105)



Modified from Figure 2 of Hedman et al. (2013, Icarus)

See more at www.stsci.edu/jwst and jwst.nasa.gov